Developing Functional Analysis-Informed Interventions to Reduce Mouthing in Dogs

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DEVELOPING FUNCTIONAL ANALYSIS-INFORMED INTERVENTIONS TO REDUCE MOUTHING IN DOGS

by

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ABSTRACT
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In human populations, the most efficacious behavioral interventions are function-based, which first requires identification of the behavioral function. The gold standard for isolation of the behavioral function is the functional analysis, which has been effectively used for decades on human behavior. However, companion animals also engage in behavior considered problematic by their human owners. In domesticated dogs, mouthing is a common behavior displayed by young dogs and is considered problematic by many human families. Without efficacious interventions, undesirable behavior in companion animals may result in reduced welfare, relinquishment, or even euthanasia of the animal. The purpose of this study was to apply the functional analysis to identify the function of mouthing behavior in dogs. The results of the functional analysis led to the identification and implementation of function-based interventions that reduced mouthing behavior in all three dogs.

ACKNOWLEDGEMENTS

Mindy R. Waite

It is said that one should "give credit where credit is due." However, I owe so much more than credit to so many people along this remarkable journey, and I cannot even begin to describe how in awe and indebted I am for the hard work and passion of so many.

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Significant credit goes to the human families and their dogs who enrolled in our functional analysis study and spent many hours with me and their dogs' mouths. Their efforts will help other families struggling with dog behavior problems and has hopefully improved their own lives as well.

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Introduction

Companion animals commonly engage in behavior considered problematic to their owners (Gazzano et al., 2008; Salman et al., 2000), and problem behavior is a common cause of animal abandonment or euthanasia (Patronek, Glickman, Beck, McCabe, & Ecker, 1996a; Patronek, Glickman, Beck, McCabe, & Ecker, 1996b; Patronek & Dodman, 1999; Reisner, Erb, & Houpt, 1994; Shore, 2005). Several types of animal behavior professionals are available to assist families with their pets' problem behavior; however, few behavioral assessments have been validated in the pet population. As a result, animal behavior experts rely on personal experience and tools lacking validation in the species of interest. The result is that indirect or subjective assessments are typically used to hypothesize the variables maintaining animal problem behavior. For example, a typical behavioral consultation begins with collecting owner reports of the behavior and antecedent/consequent variables (Casey & Bradshaw, 2008; Landsberg, Hunthausen, & Ackerman, 2013; Reisner, Shofer, & Nance, 2007). The initial meeting may include relatively brief direct, descriptive evaluations of the animal and its behavior by the consultant, either in-person or via video recording. Veterinary behavior consults will also include a medical assessment (Horwitz, 2017). Based on these brief indirect and direct assessments, an intervention protocol is developed. After several weeks of the intervention, most consultants will again rely on indirect, subjective owner assessments or brief direct assessments to evaluate success (Horwitz, 2017; Landsberg et al., 2013).

Although descriptive assessments are commonly used in animal behavior consulting, these assessment types have been shown to be inaccurate and unreliable in humans (Iwata, Deleon, & Roscoe, 2013; Kahng et al., 1998; Lerman & Iwata, 1993; Mace & Lalli, 1991; Cathleen C. Piazza et al., 2003; Smith, 1995; St Peter et al., 2005; Thompson & Iwata, 2007). For human behavior problems, behavioral function is typically assessed using the functional analysis, which can elucidate the maintaining variables for various behavioral topographies (Iwata et al.,

1994; Iwata, Dorsey, Slifer, Bauman, & Richman, 1994; Smith, Iwata, Vollmer, & Zarcone, 1993). Common behaviors assessed by the functional analysis include aggression (Hagopian, Rooker, Jessel, & DeLeon, 2013; Thompson, Fisher, Piazza, & Kuhn, 1998), stereotypy (Miltenberger, Long, Rapp, Lumley, & Elliott, 1998), destructive behavior (Bowman, Fisher, Thompson, & Piazza, 1997), and other behaviors harmful to the individual or others (C. C. Piazza, Hanley, & Fisher, 1996). Although the functional analysis has been used in human behavior for decades and is often part of a comprehensive treatment plan for human problem behavior, there has been little translation into the animal behavior field, either at the level of research or clinical application.

More recently, studies have assessed the validity of the functional analysis on animal behavior. The seminal human-to-animal translational study demonstrated the validity of the functional analysis to identify positive reinforcement in the form of attention as the function of self-injurious behavior in a single olive baboon, and the results informed an efficacious, function-based intervention (Dorey, Rosales-Ruiz, Smith, & Lovelace, 2009). Follow-up functional analysis studies were conducted on companion dogs to identify the function of jumping on people (Dorey, Tobias, Udell, & Wynne, 2012), identify the function of canine stereotypy/OCD (Hall, Protopopova, & Wynne, 2015), confirm that access to the owner functions as a reinforcer for dogs (Feuerbacher & Wynne, 2016), and identify the function of problematic dog behavior in the shelter (Winslow, Payne, & Massoudi, 2018).

The functional analysis of dog jumping behavior included standard conditions such as ignore, attention, play, demand, and tangible (Dorey et al., 2012). The identified function of jumping was positive reinforcement in the form of access to tangible items in two dogs and attention in one dog. Treatments developed to address the identified functions were efficacious. In contrast, a functional analysis of dog stereotypy consisted of unique conditions specific to each dog's behavior (Hall et al., 2015), and all interventions tested were efficacious, although often requiring the use of punishment. For example, the functional analysis for a dog engaging in

continuous self-licking included attention, alone, and control (noncontingent attention) conditions, and results only identified an attention function. However, clinically-relevant decreases in behavior required timeout in addition to differential reinforcement with attention extinction.

These earlier studies suggest that the functional analysis can identify the contingencies maintaining animal problem behavior. Nevertheless, the necessity of punishment for two dogs without an identified automatic function for stereotypic behavior in Hall et al. (2015) may suggest that not all behavioral functions were identified or that punishment is required to reduce some behaviors, consistent with the human literature (Fisher et al., 1993; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Rooker, Jessel, Kurtz, & Hagopian, 2013). Additionally, although two studies used research team members as the experimenter engaging with the canine participants during the functional analysis for problem behavior (Dorey et al., 2012; Hall et al., 2015), switching the owner into the experimenter role in one study resulted in different behavioral frequencies (Hall et al., 2015), suggesting that analyses may need to incorporate owners into the experimenter role to maximize accuracy. Further, the dog functional analysis studies on problem behavior focused on repetitive and jumping behaviors, whereas many other canine problem behaviors exist, and the validity of functional analyses of other behaviors is unknown.

"Mouthing" is thought to be a common behavior problem in pet dogs (Gazzano et al., 2008) and was previously operationally defined as the "dog places teeth on person regardless of force" (Protopopova & Wynne, 2014, p. 111). A study on 46 Italian dogs suggested that 37% of the dogs aged 11-18 months engaged in mouthing (Gazzano et al., 2008). However, no operational definition of the behavior was provided, the dogs were enrolled through a single veterinary clinic as puppies, and the population size was small. Therefore, their sample may not represent the general pet dog population. Despite the absence of empirical data, it is widely believed that puppies engage in mouthing more frequently than older dogs and that the function

of mouthing potentially differs by age. For example, the teething phase in puppies occurs at two to seven months of age and is a result of permanent teeth erupting from the gums (Arnall, 1960; Geiger, Gendron, Willmitzer, & Sánchez-Villagra, 2016). This developmental process likely causes physical discomfort, which could establish the reduction in discomfort as an automatic negative reinforcer. Similarly, parents of human children perceive that infants in the teething phase are more likely to bite and suck on objects, engage in abnormal gum-rubbing, and be more irritable (Macknin, Piedmonte, Jacobs, & Skibinski, 2000).

Mouthing is considered a problem behavior regardless of dog age because it can result in damage to human skin through bruising, scratches, or open wounds and because it may be highly aversive to owners and other people, given its potential for topographical and functional overlap with "biting." A variety of colloquial recommendations exist to reduce mouthing frequency. These include yelping when mouthed to mimic other puppies in the litter, giving the dog a timeout, ignoring the dog when it mouths (Seksel, 2008), and giving the dog a chew toy as a distraction. However, the function of mouthing in puppies and dogs is unknown, as no functional analyses have been validated or performed on the behavior. Further, no interventions for mouthing have been experimentally validated. This is problematic, given that interventions which do not address the maintaining contingencies risk inefficacy or, worse, reinforcement of the problem behavior (Iwata, Pace, Cowdery, & Miltenberger, 1994). The fact that many dogs continue to engage in mouthing into adulthood (Gazzano et al., 2008) suggests that the commonly recommended interventions may not be widely effective and that validation of a tool to identify the function of mouthing in dogs is necessary to develop efficacious treatments. To that end, the purpose of this study was to determine whether a functional analysis can accurately and reliably identify the function of mouthing in pet dogs.

Method

Participants, Setting, and Materials

Dogs living with their owners within the greater Milwaukee area were recruited via flyers at shelters, dog training businesses, veterinary clinics, and online canine-focused groups. Participants were eligible for enrollment if their dog frequently engaged in mouthing behavior on the owner. Dogs had to be at least 10 weeks old, living in the home for a minimum of one month, have their sight and hearing intact, and have proof of rabies vaccinations. For safety purposes, dogs were excluded if they had ever engaged in behaviors that the owners described as "aggressive," such as snarling, snapping, lunging, growling, or biting behavior not related to play (Borchelt, 1983; Radosta-Huntley, Shofer, & Reisner, 2007) or had a history of mouth contact that produced open wounds on human skin requiring medical intervention within the last three years. Participating owners were over 18 years old.

Owners were first screened via online survey for inclusion/exclusion criteria, and the remaining eligible participants were contacted via phone to discuss the study. Of the 29 owners who were screened online, 19 were eligible and submitted their contact information. All eligible owners were contacted, resulting in enrollment of six dogs and their owners into the study. Three dog/owner pairs completed the study. Two dogs dropped out of the study because they did not engage in mouthing during early sessions, and one dog dropped out due to lack of owner availability.

Oliver was a male, 5-month-old mixed breed adopted from a local shelter at the age of 8 weeks from a litter of four. He did not mouth on the male owner, but frequently engaged in mouthing on his female owner, including placing his mouth on her arms/legs or tugging on her clothes, typically in the backyard of the home. This behavior started almost immediately upon adoption. Although he only weighed 20 lbs, his mouthing behavior produced some bruising or broken skin not requiring medical attention. His owners reported that they frequently engaged in

tug games with Oliver during which both owner and dog simultaneously pulled on a toy. Oliver's assessment was performed in his backyard with his female owner.

Bubbles was a female, 6-month-old golden doodle purchased from a breeder at 8 weeks old from two litters of 15 puppies. She frequently engaged in mouthing on both of her owners at home, and the behavior was especially frequent when the owners were sitting on the couch in their living room or wearing clothing with loose fabric, such as the belt on a bathrobe. Mouthing started almost immediately upon adoption. At the time of enrollment, the behavior was producing bruises, and the owners reported mouthing was increasing in severity. Bubbles' assessment was performed in the owners' living room with the male owner.

Wilbur was a male, golden retriever puppy aged 4.5 months at the time of enrollment. He was purchased from a breeder at 8 weeks from a singleton litter. He frequently engaged in mouthing on his female owner since adoption. Although the mouthing behavior was typically gentle, he still had deciduous teeth, which are sharper than adult teeth (Fulton, Fiani, & Verstraete, 2014) and can easily scratch human skin. Wilbur's assessment was performed inside the living room of his home with his owner.

Due to the reported high frequency of mouthing, owners wore protective equipment in the form of padded cloth arm guards and, if applicable, shin guards during sessions of assessment and treatment. To assist with discrimination between the conditions of the functional analysis, five pairs of arm guards were dyed different colors known to be discriminable by dogs, including white, grey, black, yellow, and blue (Neitz, Geist, & Jacobs, 1989; Pretterer, Bubna-Littitz, Windischbauer, Gabler, & Griebel, 2004). Each color was consistently paired with a specific functional analysis condition within and across dogs. White arm guards were paired with ignore, grey with attention, black with control, yellow with demand, and blue with tangible.

Owners identified toys and demands for inclusion in functional analysis conditions. Owners selected toys with which their dog frequently played for inclusion in the toy play condition, and the putatively most preferred toy (based on owner report) was included in the

tangible condition. Demands to which the canine participants consistently complied, as well as small edibles used during training of cues, were included in the demand condition.

Response Measurement, Interobserver Agreement, and Treatment Integrity

The primary dependent variable was mouthing on an owner, defined as the dog's teeth or inner lips making contact with human skin or clothing. Contact solely by the tongue (licking) was excluded. This definition is similar to, but more comprehensive than, the definition proposed by Protopopova and Wynne (2014). Videos of each session were scored using partial-interval recording with 10-s intervals across each 5-min session. Mouthing data were converted to a percentage by summing the intervals in which mouthing occurred, dividing by the total number of intervals in the session, and multiplying by 100.

Secondary dependent variables were collected during intervention only. Intervention dependent variables for Oliver and Bubbles included down stay and/or sit stay. Stay behaviors required holding a specific body position for a set time duration. Down stay is when a dog lies in sternal recumbency and was defined as when a dog's elbows, abdomen, and rear pasterns were touching the ground. Sit stay was defined as the dog's rear pasterns and rump in contact the ground. Data collectors scored the duration of sit say behavior for Oliver and the latency to sit stay behavior for Bubbles.

Two trained observers collected interobserver agreement data for mouthing behavior on 41.7% (43/103) of assessment and treatment sessions. Agreement was defined as both observers scoring either the occurrence or absence of behavior during the same interval. Mean agreement for mouthing behavior was calculated by dividing the number of intervals with an agreement by the total number of intervals per session, multiplied by 100. Mean agreement was 97.6% (range, 86.7% to 100%) for Oliver, 95.9% (range, 83% to 100%) for Bubbles, and 96.2% (range, 80% to 100%) for Wilbur.

Data also were collected on procedural fidelity during 100% of functional analysis, training, and intervention sessions to examine whether the owner made errors of omission, errors

of comission for problem behavior, or errors of comission for other behavior. Omission errors were defined as the owner failing to provide programmed reinforcement within 3 s of target behavior. Comission errors for problem behavior occurred when the owner provided unprogrammed reinforcement for mouthing behavior. Commission errors for other behavior were defined as the owner providing unprogrammed reinforcement for a non-target response. Total errors were calculated using partial-interval recording by dividing the total number of intervals with errors by the total number of intervals. Integrity data are reported as the percentage of intervals in which the owner implemented the assessment or intervention procedures as described in the protocol and did not make any of the previously described errors.

During the functional analysis, integrity for Oliver's owner was 99% (range, 90% to 100%), 95% for Bubbles' owner (range, 76.7% to 100%), and 95.3% (range, 76.7% to 100%) for Oliver's owner. Errors of omission never occurred, and errors of comission for problem or other behavior were relatively rare. Interestingly, comission errors of other behavior were most likely to occur during the attention condition, wherein noncontingent attention was provided by Bubbles' and Wilbur's owners during an average of 14.0% and 9.3% of intervals, respectively. These comission errors typically occurred when the dog engaged in desirable behavior, to which the owner provided encouraging statements (e.g., "Good girl!" or "You're so cute") or petting.

During the intervention training sessions, treatment integrity was 99.2% for Oliver (range, 98% to 100%), 97.6% for Bubbles (range, 83.3% to 100%), and 95.3% for Wilbur (range, 96.7% to 100%). During intervention sessions, treatment integrity was 100% for Oliver, 98.7% for Bubbles (range, 96.7% to 100%), and 94.7% for Wilbur (range, 83.3% to 100%). During training and intervention sessions, owners never engaged in errors of omission. Similar to the functional analysis sessions, errors of comission of other behavior were the most common error, and errors of omission never occurred.

Functional Analysis

A functional analysis was conducted for each dog. Conditions included ignore, attention, toy play, demand, and tangible. Conditions were typically presented in a consistent order, unless noted otherwise, and alternated in a multi-element design with no more than 10 sessions per day. Each session was 5 min in duration.

Sessions occurred in the setting in which the owner reported the highest frequency of mouthing. The owner conducted each condition with his/her dog. A researcher also was present to provide feedback during the functional analysis and video record the session.

Ignore. The owner was present but did not interact with his/her dog nor provide any attention contingent on mouthing or any other behavior.

Attention. The owner withdrew his/her attention from the dog. Contingent on mouthing, the owner provided attention. The topography of attention provided by the owner was consistent with the manner in which the owner typically interacted with him following mouthing, and there was no required minimum interval length. For example, Oliver and Bubbles' owners said "no" and pushed Oliver or Bubbles away contingent on mouthing, whereas Wilbur's owner laughed, talked to Wilbur, and gently played with Wilbur's mouth and paws for approximately 10 s.

Toy play. Toys and owner attention were consistently available. The owner provided his/her typical attention and played with his/her dog. Interactions included vocal attention (e.g., high-pitched praise, such as "You're such a good girl!" or other statements to/about the dog, such as "Go get it" when a toy was thrown), petting, and playing with toys (e.g., squeaking, shaking, or throwing toys). Contingent on mouthing, the owner did not respond nor change his/her behavior and continued the activity. Available toys were chosen by owners based on their interpretation of the dog's preference.

Demand. The owner continuously presented previously trained prompts to the dog (e.g., sit, down, stay, shake). Contingent on a correct response by the dog, the owner delivered a small edible. If the dog did not respond correctly, the owner continued to present the prompt

approximately every 3 s. Contingent on mouthing, the owner removed the demand by turning away and ignoring the dog for 20 s.

Tangible. Toys were selected for inclusion based on the owner's nomination of the dog's putatively most preferred toy. The owner provided access to a preferred toy for 20 s contingent on mouthing. After 20 s, the owner attempted to retrieve the toy. When the owner went to retrieve a toy, if the dog did not release it, the owner allowed the dog to keep the toy in order to avoid social attention in the form of a tug game. The owner was then asked to retrieve the toy when possible during the session, such as when the dog was distracted. To ensure reinforcers were available for every instance of mouthing, the owner had access to two similar toys (e.g., two fox-shaped tug toys). If the dog mouthed while already in possession of a toy, the owner gave the dog the second toy and concomitantly attempted to retrieve the first toy.

For both Bubbles and Wilbur, toys were easily retrieved when necessary. In contrast, Oliver often ran away with toys or engaged in tug games and would not release the toy. Whenever his owner reached down to pick up a toy at the end of a reinforcement interval, he consistently lunged toward the owner's hand and mouthed the owner or grabbed the toy for which the owner was reaching, resulting in further toy access when the owner released the toy to avoid tug games. As a result, Oliver had access to at least one toy outside of reinforcement intervals (unscheduled EO absent) for an average of 55.7% of the duration of tangible sessions.

Treatment

Based on the results of each dog's functional analysis, the experimenter developed an individualized intervention to address the function(s) of mouthing. Each intervention session was 5 min. An ABAB reversal design was used to evaluate the effects of intervention on mouthing with baseline (A) and intervention (B) sessions. Owners conducted all baseline and intervention sessions.

During baseline, owners provided the reinforcer associated with the highest levels of problem behavior from the functional analysis contingent on mouthing. The attention condition

from the functional analysis served as the initial baseline for Oliver and Wilbur, whereas an attention baseline was conducted for Bubbles. The one-session reversal following intervention with each dog was conducted in an identical manner to the attention condition in the functional analysis.

Oliver's intervention included differential reinforcement of incompatible behavior (DRI) with extinction (EXT), during which the owner prompted Oliver to engage in a 5-s stay. Contingent on Oliver staying in a down position for 5 s, his owner provided attention and tangible access in the form of 15 s of a tug game with a toy and verbal attention. Contingent on mouthing, Oliver's owner implemented attention EXT by turning away and ignoring him for 10 s and tangible EXT by not providing access to any tangible items. To train the stay behaviors, a changing-criterion design was used, wherein topography and duration of incompatible responses were modified across criteria. If Oliver's behavior met the criterion two sessions in a row, the duration criterion was increased or topography changed. However, if Oliver's behavior did not meet the criterion two sessions in a row, the criterion was decreased to the previous step. Criteria included holding a stay for 5 s, 8 s, 12 s, 15 s, 20 s, 23 s, and 25 s. Phases included down-stay behavior, then sit-stay behavior, then sit stay while the owner walked around. The terminal criterion for intervention was for Oliver to remain in the sit-stay position for at least 20 s while his owner walked around the yard, as this would allow his owner enough time to enter and cross the backyard, briefly enter the house, and return with a toy to provide reinforcement (e.g., tug game and attention).

Bubbles' intervention included DRA with EXT to gain access to a tug game or ball throw with concomitant verbal or physical owner attention. The alternative behavior consisted of Bubbles picking a toy up from the ground, bringing the toy within a 0.33-yard radius of the owner, and sitting within a 0.33-yard radius of the owner. Contingent upon Bubbles engaging in the alternative behavior, the owner immediately provided brief praise, picked up the toy, and engaged in a tug or ball throw with the toy and Bubbles for 15 s. To establish the DRA, Bubbles

underwent alternative behavior training using a changing-criterion design with multiple prompt fading. Bubbles had already learned to sit in response to the owner's verbal/visual prompts while the owner was standing. Training began with the owner putting the toy on the ground several feet away, standing up, then providing several verbal and visual prompts for "sit". Training ended with the owner sitting on the couch not looking at Bubbles, and Bubbles engaging in the alternative behavior without any prompting. Any mouthing resulted in the owner turning away and not providing attention for 10 s. The criterion for changing phases was a latency to sit under 20 s for a minimum of three trials in a row.

Wilbur's intervention included a multiple schedule, and all sessions were 5 min in duration. During the reinforcement schedule in initial training, Wilbur had 60-s of continuous access to toys and owner attention, and any mouthing behavior resulted in the owner turning away for 10 s. During the extinction schedule, the owner turned away, crossed her arms, and said, "Not now." All subsequent behavior by Wilbur was ignored until the end of the session, and Wilbur continued to have noncontingent access to toys. Following training, the intervals increased to 150 s because of the owner's need to signal the unavailability of attention reinforcement while she performed work tasks throughout the day.

Results

The functional analysis included 25-31 sessions per dog, for a total of 125 to 155 min over four to six days. The functional analysis was conducted over a two-to-seven-week period, based on the owners' availability for appointments.

Figure 1 shows Oliver's functional analysis results. Oliver engaged in mouthing during a high percentage of intervals in the attention, ignore, and tangible conditions. In the attention condition, when the magnitude of the owner's physical attention increased (e.g., occasional forceful shoving Oliver away), Oliver's mouthing became much more intense (quickly lunging) and he engaged in other behavior (e.g., barking), suggesting potential differences in the quality of

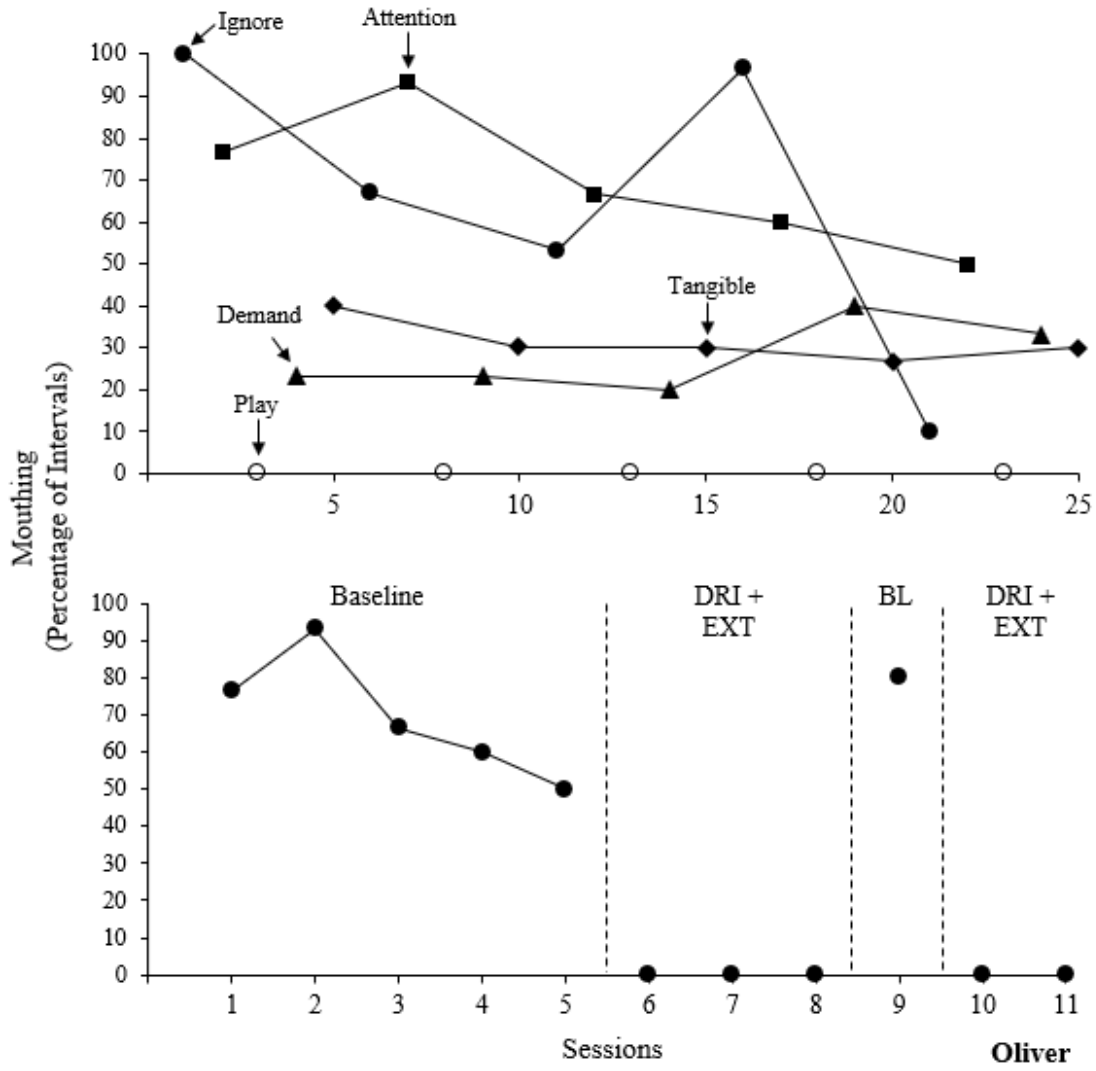

Figure 1. The percentage of mouthing during Oliver's functional analysis (top panel) and function-based treatment (bottom panel). Data from the attention condition of the functional analysis are duplicated in the initial baseline phase of treatment. BL = Baseline; DRI = Differential reinforcement of incompatible behavior; EXT = Extinction.

types of attention as reinforcers. During the tangible condition, Oliver engaged in mouthing during 26.7% to 40% of intervals. Oliver's owner was unable to remove the tangible item during some intervals. During reinforcement intervals and following reinforcement intervals when the owner could not remove the tangible item due to Oliver's tugging behavior, Oliver frequently engaged with the toy in his possession. However, if the owner reached for a nearby toy, Oliver would leave his current toy in order to mouth or grab the toy for which the owner was reaching. Oliver had near-zero levels of mouthing in the toy play. Although Oliver mouthed during some

demand intervals, 51.8% of this mouthing occurred during the inter-demand interval (i.e., EO absent interval). Also, although Oliver initially engaged in high levels of mouthing in the ignore condition, the frequency decreased with additional exposure to the contingencies in the condition. These data suggest that Oliver's mouthing was maintained by social positive reinforcement in the form of attention and access to tangible items.

Oliver's treatment was developed to address attention and tangible reinforcers for mouthing and included DRI with EXT. His functional analysis attention sessions served as his initial baseline for the treatment phase. In all treatment sessions, Oliver did not engage in mouthing (Figure 1). However, during the reversal to a baseline attention condition, mouthing occurred during 80% of intervals. Mouthing decreased to zero levels following the reintroduction of treatment. These data indicate that Oliver's treatment was highly efficacious in reducing his mouthing.

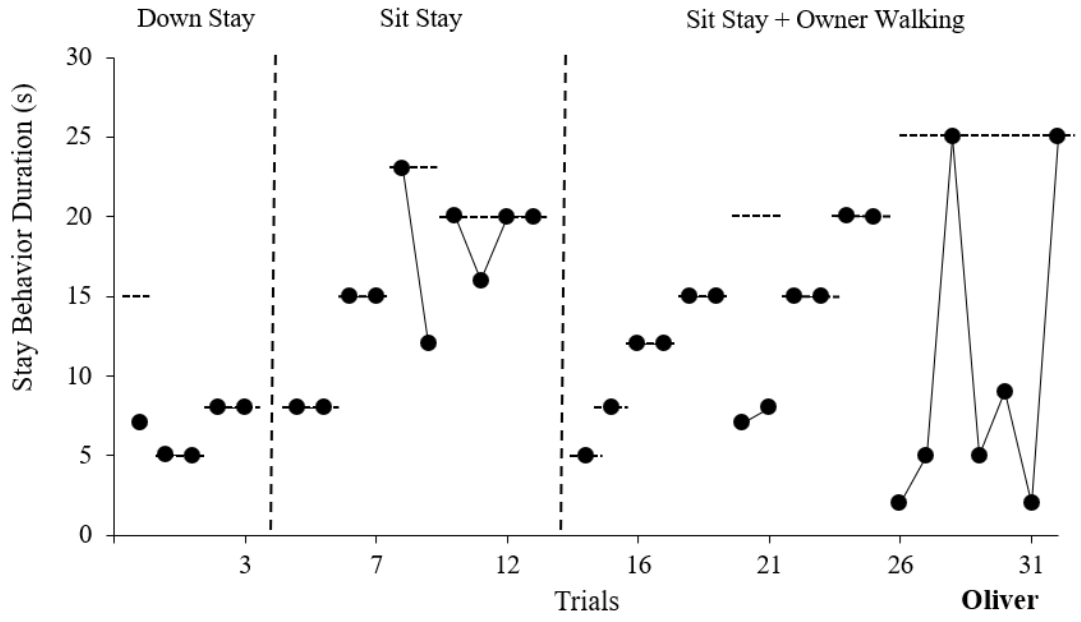

Figure 2. Duration of stay behavior during DRI training for Oliver.

Following the successful intervention, Oliver was trained using delay fading of the reinforcer to increase the duration of sitting behavior, thus allowing the owner to walk from her detached garage to her house through the backyard without mouthing occurring (Figure 2). Oliver

was able to successfully complete a 20-s sit-stay behavior while the owner walked through the yard to her backdoor. Oliver did not achieve success for 25 s, potentially because of fatigue (25 trials had occurred in the previous hour) due to time constraints. Several weeks after training, the owner reported that Oliver continued to sit-stay while the owners walked through the backyard from garage to house.

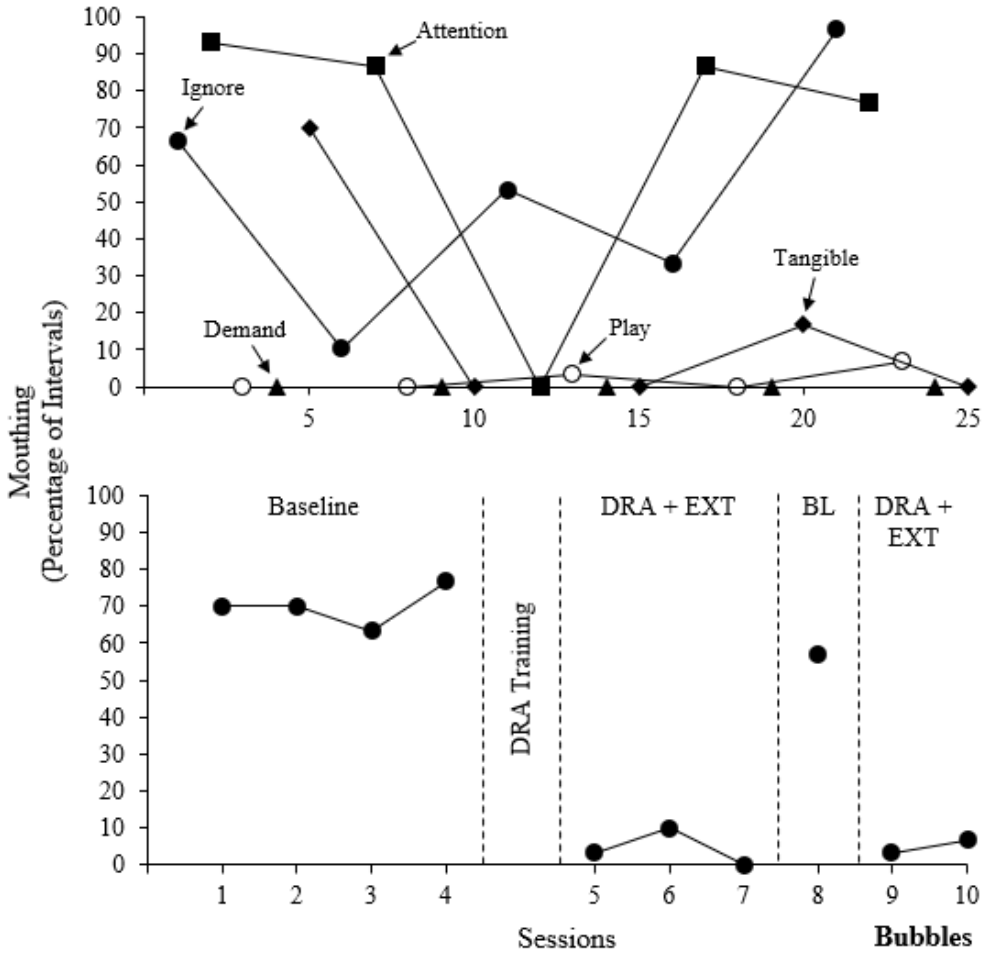

Figure 3. The percentage of mouthing during Bubbles' functional analysis (top panel) and function-based treatment (bottom panel). BL = Baseline; DRA = Differential reinforcement of alternative behavior; EXT = Extinction.

Figure 3 shows the results of Bubbles' functional analysis. Bubbles engaged in high levels of mouthing behavior in the attention and ignore conditions, suggesting that the behavior was maintained by positive reinforcement in the form of attention. Similar to Oliver, when

Bubbles' owner provided a higher magnitude of physical attention (forceful shoving away), the intensity of Bubbles' behavior increased with barking, jumping, and rapid lunging, suggesting the topography of owner attention may impact behavior. Mouthing remained low in the demand, tangible, and toy play conditions. An extended ignore condition was not conducted due to time limitations; thus, we were unable to rule out automatic reinforcement as another function of Bubbles' mouthing.

Bubbles engaged in high levels of mouthing during the initial attention baseline (bottom panel of Figure 3). After intervention training, there was an immediate reduction in Bubbles' mouthing behavior during DRA with EXT. The reversal to baseline showed high levels of mouthing. Following the reintroduction of treatment, Bubbles' mouthing reduced to low levels.

During intervention training, Bubbles was trained to engage in the alternative behavior via changing criteria and fading of owner prompts. During training, Bubbles mouthed on her owner across 15.8% of trials. The latency to sit gradually reduced for each criterion as owner prompts to sit were faded and attention EXT was introduced. By the end of training, Bubbles

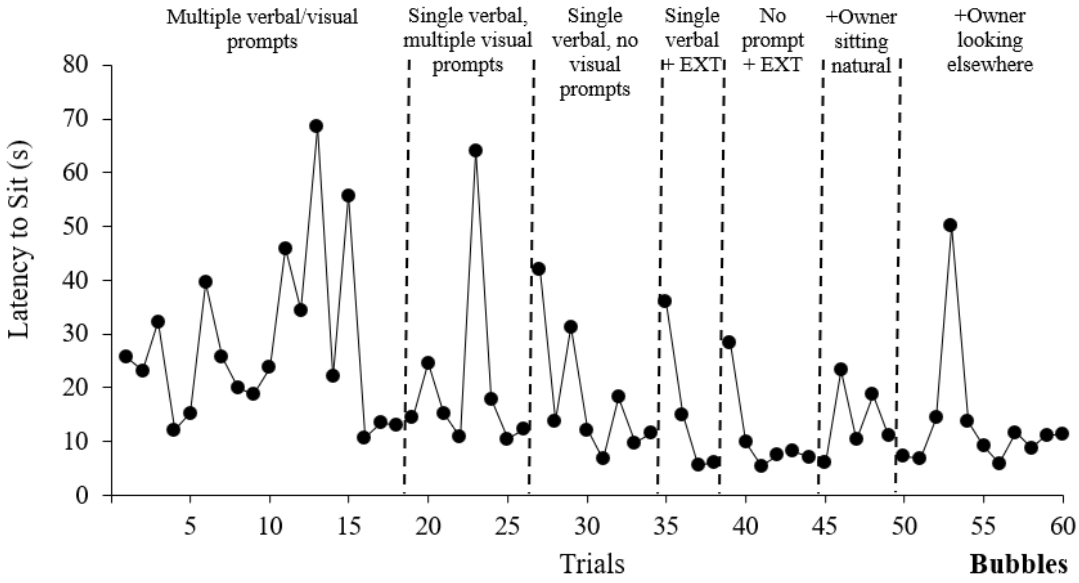

Figure 4. The latency to sit during DRA training for Bubbles. EXT = Extinction.

engaged in alternative behavior without any prompting while the owner was sitting on the couch and ignoring her (Figure 4).

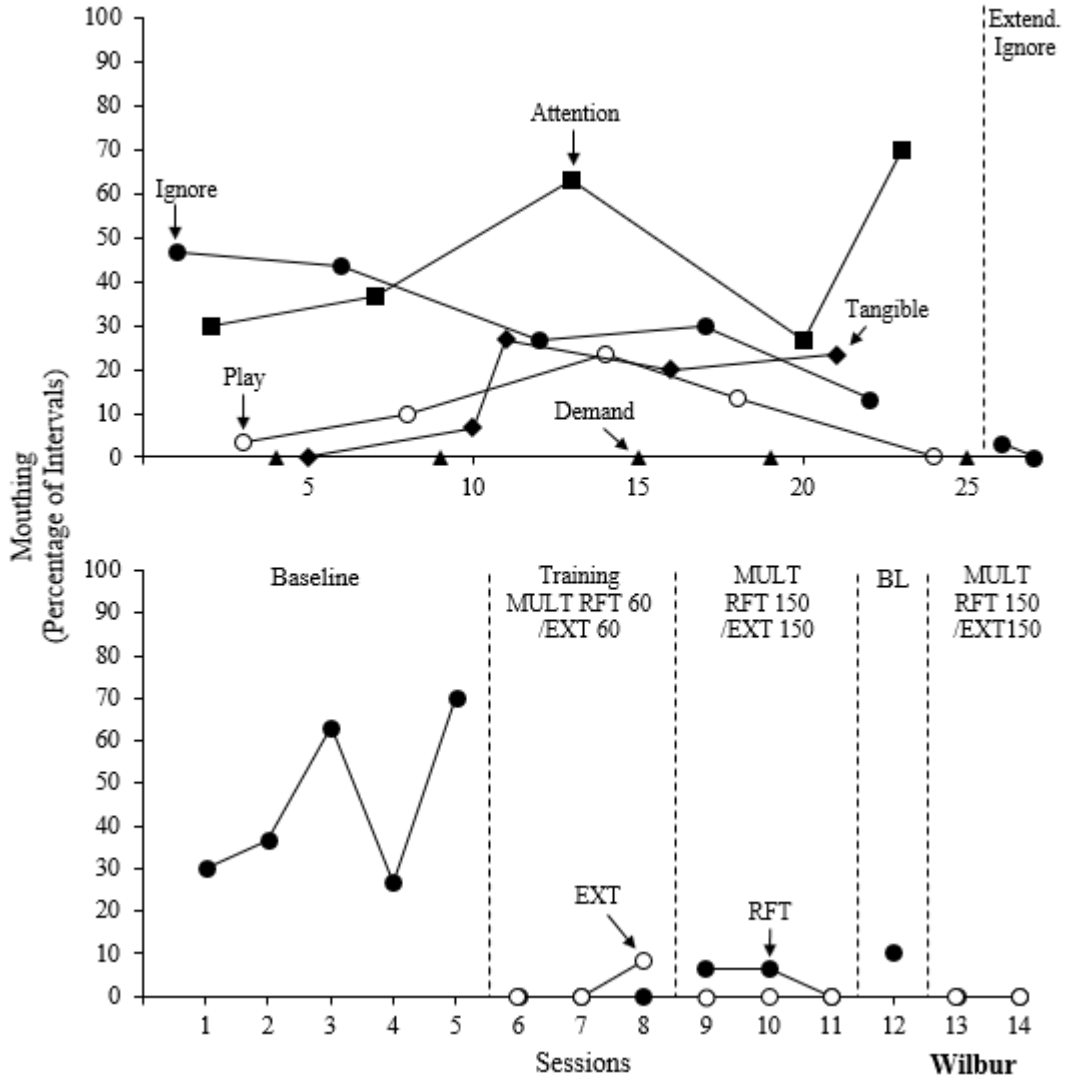

Figure 5. The percentage of mouthing during Wilbur's functional analysis (top panel) and function-based treatment (bottom panel). Data from the attention condition of the functional analysis are duplicated in the initial baseline phase of treatment. BL = Baseline; MULT = Multiple schedule; RFT = Reinforcement; EXT = Extinction.

Figure 5 shows the results of Wilbur's functional analysis and treatment. Wilbur consistently engaged in high levels of mouthing during the attention condition, whereas the behavior decreased in other conditions after repeated exposures. Although Wilbur's mouthing

was elevated in early ignore sessions, levels of mouthing decreased over time, and an extended ignore session (10 min) resulted in substantial decreases in mouthing.

During intervention training (MULT RFT 60/EXT 60), Wilbur's mouthing behavior only occurred once, and mouthing remained low during intervention sessions (bottom panel). During the MULT RFT 150/EXT 150 intervention, Wilbur frequently engaged with his owner and toys. However, during the EXT schedule where no owner attention was available, he stopped engaging with toys or his owner and lay down. He showed delays to re-engage with his owner during the following RFT schedules. This lack of re-engagement was evident during the reversal to baseline session. Although mouthing behavior occurred in the return to baseline, it did not increase to pre-intervention levels. Additional baseline sessions could have been conducted to further test the behavior reversal; however, the owner was pleased with the low levels of mouthing behavior produced during treatment and concerned about additional baseline sessions.

Discussion

Results from these participants suggest that the functional analysis was a valid tool for identification of the function of mouthing in companion dogs. The functional analysis showed differentiated levels of responding across conditions and thereby identified functions of the mouthing behavior in all three dogs. Attention was a functional reinforcer for mouthing in all three dogs, and mouthing was maintained by access to tangible items for one dog (Oliver). Additionally, the results informed efficacious interventions through the removal of reinforcers for mouthing and programming of differential reinforcement for alternative, more desirable behaviors.

Each dog received a reinforcement-based intervention based on the results of the functional analysis and the owner's feedback regarding preferred alternative behaviors. Two dogs (Oliver and Bubbles) received differential reinforcement with EXT, and one dog was exposed to a multiple schedule to signal periods of reinforcement versus extinction. Nevertheless, none of

the dogs in the present study required punishment to reduce mouthing, unlike dogs in previous studies (e.g., Hall et al., 2015). It is possible that including owners in all assessment and treatment sessions and conducting sessions in the dog's natural environment increased the validity of the functional analysis outcomes, thereby permitting identification of a function-based intervention.

These results also show that the owner can be successfully incorporated into assessment and treatment procedures, consistent with previous studies (Hall et al., 2015), and that owner participation with researcher supervision results in relatively few errors. Owner errors were rare and only consisted of errors of comission. Further, the comission errors typically occurred after a non-target behavior (e.g., the owner provided attention when the dog sat still and looked up at the owner); thus, errors reinforcing the mouthing behavior were uncommon during treatment. These low levels of errors of omission and comission of other behavior are consistent with the error patterns emitted by parents providing behavioral interventions to their children (Arkoosh et al., 2007). Additionally, the intervention success despite some errors is consistent with previous studies demonstrating that intervention efficacy is reduced with high levels of integrity errors (over 60%) of either omission or comission (St Peter et al., 2005), but problem behavior can be successfully reduced with high integrity for reinforcement of desired or non-target behaviors (Arkoosh et al., 2007). Although incorporating owners in assessment and treatment sessions requires significant owner effort (>2.5 hr across several days) and includes some level of error, owner inclusion can ensure the results are specific to the unique context of the home environment and offers an opportunity for the owner to practice appropriate, new responses to behavior during treatment.

Although owners can be successfully integrated as the experimenter, inclusion of the owner potentially limits the length or number of sessions available. As a result, extended conditions were not performed for Oliver and Bubbles, and functional analysis results were used in place of treatment baseline for Oliver and Wilbur, even though behavioral trends could have been further elucidated by additional sessions. For example, Bubbles' ignore condition had high

levels of mouthing, and running extended ignore sessions could have provided further clarification. However, owner time was limited, and mouthing duration and intensity were typically very high; thus, further extension to the analysis was not a socially valid option for the owners. Additionally, owner considerations limited the length of reversals during intervention to a single session. Although reversals to baseline for Oliver and Bubbles showed high levels of mouthing and provided a demonstration of experimental control over the behavior, the reversal for Wilbur was weak. Additional baseline sessions with Wilbur would have clarified the permanence of the behavior change. However, the owner was averse to conducting more than one baseline reversal session. In future studies, owner education on the necessity of a reversal should be provided early in the analysis.

Inclusion of the owner also presented scheduling limitations, as aligning with owner schedules was challenging and caused the functional analysis to extend across several weeks, whereas more condensed assessments are likely preferable. This extended schedule could have impacted dog discrimination of conditions and allowed enough time for owners to practice interventions outside of study sessions. Future studies should further assess whether/when the owner should serve as the experimenter and whether duration between sessions impacts results.

Another limitation of the study was the length of time some dogs had access to a tangible item during the tangible condition. For example, Oliver engaged with toys when accessible, but if his owner reached to pick up that toy or another toy nearby, Oliver lunged toward and grabbed the toy being picked up or mouthed his owner. This resulted in the owner frequently releasing the toy to Oliver to avoid engaging in tugging. These behaviors suggest that toy access functioned as a reinforcer, but that engagement in a game of tug with the owner was likely a more valuable, competing reinforcer, making it difficult to retrieve toys in order to arrange EO-absent intervals within the tangible sessions. It is also possible that the tangible items only functioned as reinforcers if combined with attention. In future studies, researchers might consider conducting an additional data-informed synthesized contingency condition in which attention and tangibles are

combined if the dog's behavior suggests that combined contingencies may maintain problem behavior (e.g., Hanley, Jin, Vanselow, & Hanratty, 2014). Also, additional observers did not score secondary dependent variables during treatment. Thus, the reliability of data collected on these secondary variables is unknown, and these data should be interpreted with caution as a result of this limitation.

Overall, results suggest the efficacy of the functional analysis for identifying the function of dog mouthing. Further, given the that functional analysis has proven efficacious across multiple canine behaviors (Dorey et al., 2012; Feuerbacher & Wynne, 2016; Hall et al., 2015), the tool could potentially be applied to a variety of problem behaviors in the dog population. For high frequency problem behaviors, use of this tool in place of inferring behavioral function may increase the probability of intervention efficacy and reduce the temporal and financial effort required to test various interventions based on hypothesized functions. By facilitating earlier intervention efficacy, the likelihood of the animal being euthanized or relinquished to a shelter may be reduced. However, further validations across behaviors should be performed.

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